

# DSN Simulation System

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*This article describes the upgrading of the DSN simulation system which was accomplished to provide support of DSN development, testing, and training activities in 1970 and 1971.*

## I. Introduction

The DSN simulation system provides real-time insertion of simulated tracking, telemetry, command, monitor and operations control systems data into the DSN. Data flows originating from the simulation system are used extensively in testing and training activities to prepare the DSN and its users for coverage of planned missions.

Functional design of the DSN simulation system for the 1970 to 1971 era, and the baseline configuration of the system for *Mariner* Mars 1971 test support, were described in Refs. 1 and 2. The system requirements outlined therein have since been implemented, and the system has been utilized by the DSN and by Mission Operations for MM'71 pre-launch and pre-orbital testing and training activities. Simulation support of *Pioneer F* pre-flight activities has recently begun.

## II. System Description

The DSN simulation system consists of the DSN simulation center (SIMCEN) at JPL and the DSIF simulation conversion assemblies (SCA) at the deep space stations. The GCF provides communications among the elements

of the system. A functional diagram of the system is shown in Fig. 1.

The system is designed to operate in any or all of the following three basic modes:

(1) *Short-loop mode, SIMCEN/SFOF*. The SIMCEN receives high-speed data from the SFOF and sends simulated DSIF teletype, high-speed, and wideband data to the SFOF; SIMCEN operators provide simulated DSS voice information to the DSN Operations Center.

(2) *Long-loop mode, SIMCEN/DSIF/SFOF*. The SIMCEN sends simulated spacecraft data via GCF high-speed and wideband circuits to one or more SCAs for conversion and insertion into DSS receptacles; SIMCEN also sends SCA control and text messages via high-speed circuits. SIMCEN receives high-speed data from the DSS and extracts information needed for responsive simulation. SIMCEN and DSS-simulation operations are coordinated by voice or teletype messages.

(3) *SCA stand-alone mode, SCA/DSS*. The SCA provides on-site simulation of spacecraft signal characteristics and fixed-pattern data for insertion into DSS receptacles.

### III. System Implementation

Figure 2 shows a schematic summary of the system capabilities resulting from hardware and software improvements outlined below.

#### A. Hardware

The following items of new equipment were added to the DSN simulation system in 1970:

(1) Ten complete simulation conversion assemblies (SCA) in the DSIF, utilizing existing XDS 910 computers. Each SCA is equipped with two input-communications buffers, four output bit-stream generators, two block encoders, one convolutional encoder, four subcarrier modulators, two mixing subassemblies, and two carrier attenuation controllers.

(2) Ten RF-carrier simulation assemblies. Each assembly has two S-band-frequency test transmitters to feed the DSS receivers with carriers modulated by the SCA output. The assembly also includes signal-level attenuators, which are remotely controlled by the SCA.

(3) Additional GCF multiplexing, transmitting, receiving and demultiplexing equipment throughout the DSN, permitting communications between SIMCEN and DSIF or SFOF via three full-duplex high-speed data (HSD) channels and one half-duplex wideband data (WBD) channel simultaneously.

(4) Additional bit stream generators and receivers for interfacing EMR 6050 input/output channels to the GCF HSD and WBD communication terminals.

(5) Additional core units for the EMR 6050 in SIMCEN to increase the computer memory capacity to 32,000 words.

(6) Seven interactive television (IATV) units and two printers in the SIMCEN operations areas, and associated interface equipment at the EMR 6050 computer, to provide real-time control and display.

(7) Interface equipment connecting the Univac 1108 computers in the JPL Scientific Computing Facility (SCF) to the EMR 6050 computer in SIMCEN (50,000-bps capacity).

#### B. Software

The following new computer programs were designed and developed to implement the 1970 to 1971 simulation system functional requirements:

(1) *SCA Program*. The Data Routing Operations Program for the XDS 910 computer of the SCA provides:

(a) Generation and/or storage of test-data patterns for SCA stand-alone operating mode.

(b) Detection and input processing of data blocks received on up to two HSD or one HSD and one WBD communication channels.

(c) Extraction of data from specified portions of HSD message blocks and routing of data to output buffers.

(d) Output of data on up to four independent channels at controlled rates.

(e) Computer control of signal-conditioning simulation devices for data encoding, subcarrier frequency modulation and mixing, and carrier attenuation.

(f) Execution of SCA control functions in response to HSD messages or local entries.

(g) Printout of status and alarm messages and HSD text messages on local typewriter.

(2) *SIMCEN Programs*. Programs written for the EMR 6050 computer include:

(a) Executive system routines to provide formatting and distribution of data from two simulated spacecraft to three HSD and one WBD output channels.

(b) Executive system routines to provide drum-to-core overlay of subprograms for real-time simulation of tracking, telemetry, command, and monitor data.

(c) Tracking data subprogram to simulate DSIF output for two spacecraft, 3 DSSs.

(d) Telemetry data subprogram to generate controllable data patterns for two spacecraft, 3 DSSs.

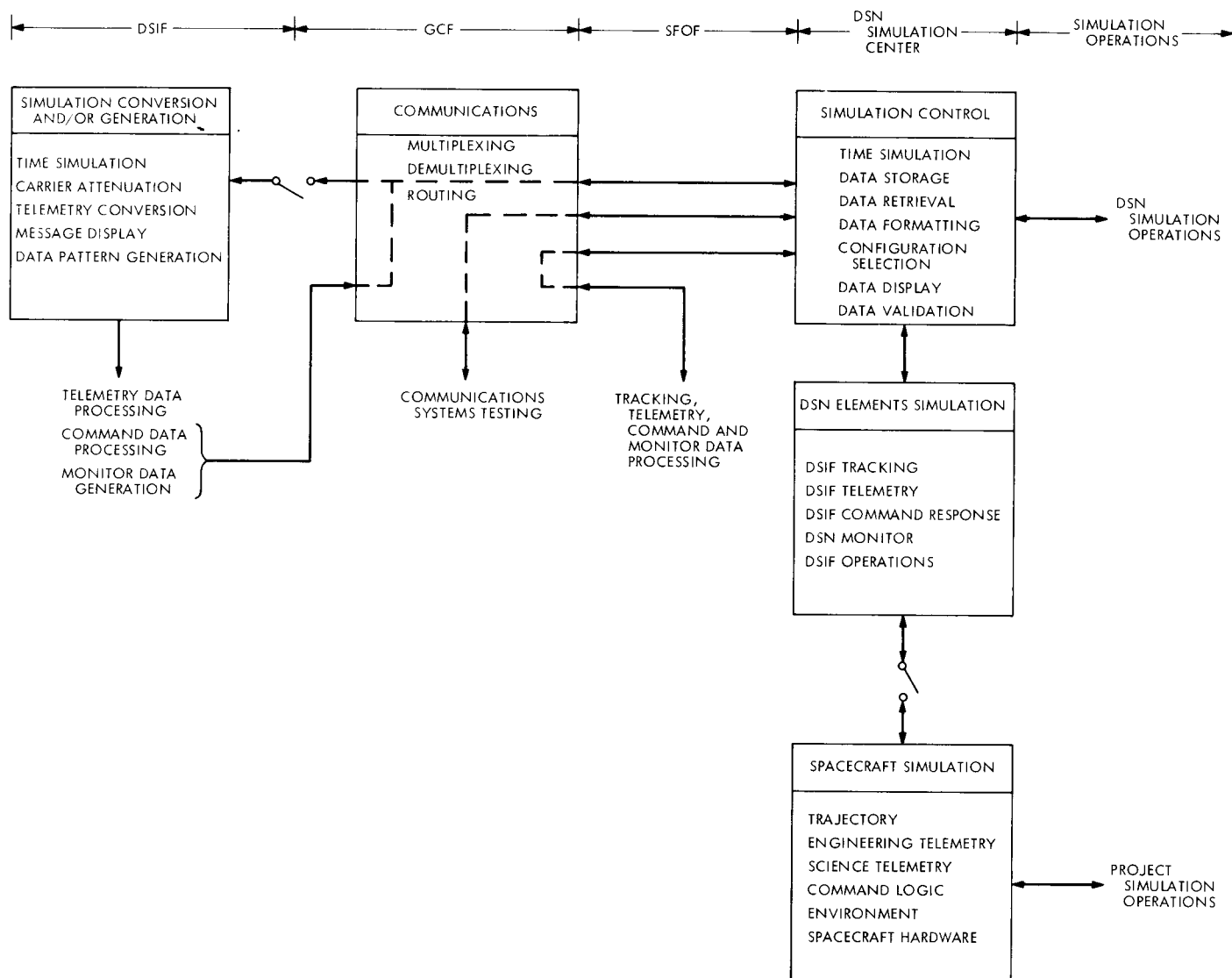
(e) Command system subprogram to simulate DSIF receiving of command messages from SFOF and outputting verification, confirmation, abort and alarm messages by up to 3 DSSs with two command processors each.

(f) Station data subprogram to provide modeling of 3 DSSs, with real-time output of simulated monitor status/performance data and monitor summary data.

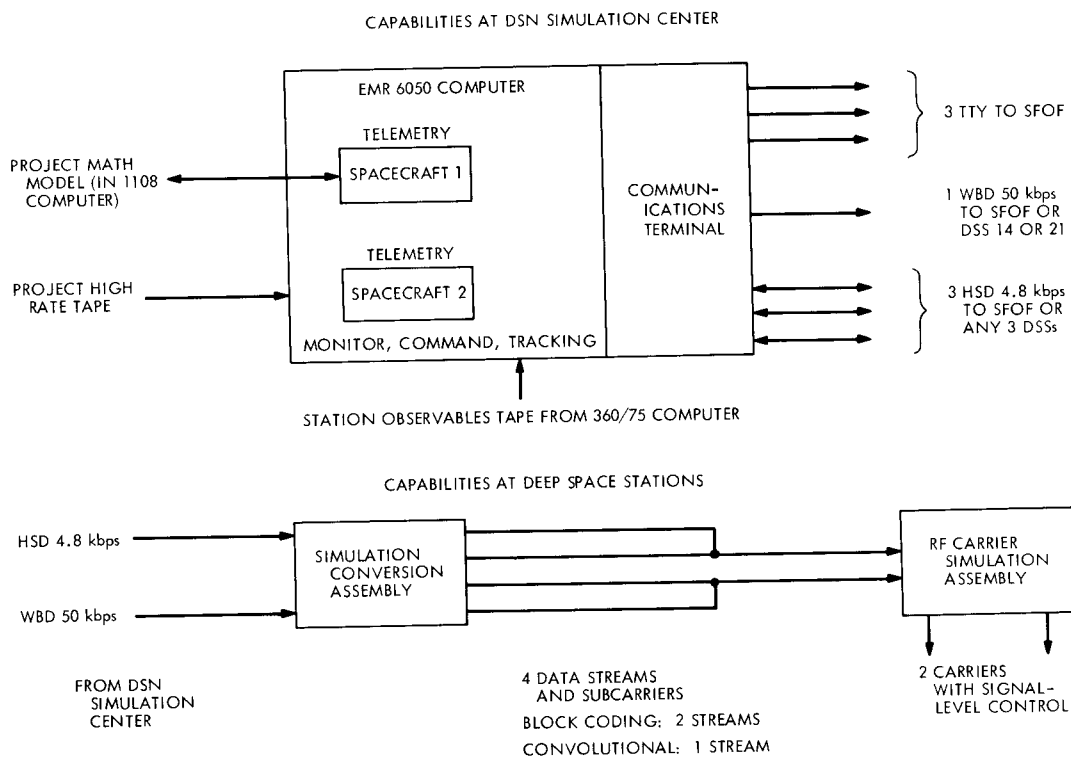
(g) Interface program for EMR 6050 to accommodate Project-supplied dynamic spacecraft math model data from SCF Univac 1108 computer and to input commands from the DSN to the spacecraft model.

## References

1. Thorman, H. C., "Simulation System," in *The Deep Space Network*, Space Programs Summary 37-61, Vol. II, pp. 3-7. Jet Propulsion Laboratory, Pasadena, Calif., January 31, 1970.
2. Laeser, R. P., "Mariner Mars 1971 Mission Support," in *The Deep Space Network*, Space Programs Summary 37-61, Vol. II, pp. 18-22. Jet Propulsion Laboratory, Pasadena, Calif., January 31, 1970.



**Fig. 1. Functional diagram of DSN simulation system for 1970-1971 era**



**Fig. 2. DSN simulation system capabilities**